Cooperation between Education and Business to Attract Young People to Engineering Education

(preliminary – work in progress)

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Cooperation between Education and Business to Attract Young People to Engineering Education (preliminary – work in progress)

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INTRODUCTION

In general, the literature on pupils' motivation in learning science emphasises the importance of out-of-school learning (Eshach, 2007; Braund & Reiss, 2006). Examples of out-of-school learning are, for instance, science festivals (http://www.formidling.dk/sw174.asp), museums, science centres (Eshach, 2007; Pedretti, 2002), children's and pupil's universities (Grunwald, 2011) etc. In recent years, we have seen a tendency for cooperation among organizations rather than single outreach activities by individual establishments; we now see cooperation, or "*a growing number of partnerships"* between communities, "*science centres, museums, and industry,"* and *"science centres and schools"* (Pedretti, 2002).

But what do we know about this kind of cooperation? How should these outreach programmes be organized? We know a great deal about the *"student's perspective"* and the *"teacher's perspective,"* and we also have some information regarding the *"non-formal institutions staff perspective"* (Eshach, 2007; Paris, Yambor & Packard, 1998). The non-formal institutions staff is, for example, employees who organize museum exhibitions, company visits, participation in a science competition, or other varieties of out-of-school science teaching activities. In neither the literature to which we refer in this paper, nor in our considerable literature research, have we found any research that examines the interaction and learning by students in a network that organizes out-of-school natural science learning. Such networks could include

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primary schools, high schools, engineering universities, companies, municipalities, etc. This seems to be the case despite a clear recognition of the fact that there is a need for "*…more collaborative research efforts … in the area of science education in non-formal settings"* (Pedretti, p. 32). This would, in practice, mean that schools should *"increase"* their cooperation with "*parents, scientists, and industry"* (Stocklmayer, Rennie & Gilbert, p. 32), while out-of-school actors should *"become unique partners for schools and colleges"* (Pedretti, p. 32). This is very important considering the fact that many teachers have problems with planning and conducting out-of-school learning because they have *"… a lack of knowledge of how to organize…"* out-of-school activities (Eshach, p. 175). Another point is that this collaboration is necessary in order to ensure that educators "… *construct bridges so that out-of-school learning … will be better connected to the in-school learning."* It is recognized that there is a potential here that has yet to be explored, and that building metaphorical bridges can be accomplished through *"more and stronger interaction"* (Eshach, p. 188), making it necessary to facilitate more common planning of these network activities:

"The outstanding need is for resources to be made available to facilitate communication and collaborative planning between informal providers and schools…" (Stocklmayer, Rennie & Gilbert, p.35).

This paper addresses this need by looking at a specific cooperation project entitled "Interaction, education, and business" (IEB), which is an organized collaboration between primary and secondary schools, businesses, and engineering education providers in the Horsens area of Jutland, Denmark. This article focuses primarily on a description of the IEB network and its activities concerning the aforementioned collaborative network aimed at organizing and supporting students' out-of-school learning.

In the first part of the paper, we introduce the IEB collaboration project and the initial theoretical approach we took in order to improve our understanding of how learning in an inter-organizational, out-of-school cooperation in science teaching can be developed, organized, and made functional. We argue that collaboration between the different actors in the network takes its point of departure in defining a network as a *"wide network"*. This refers to "*… more loosely bonded collectives of organizations [or persons] linked by geographical proximity, similar interests or activities, or participation in the production/delivery of a product or service"* (Knight, p. 430).

The second part of the paper describes and characterizes this new type of networked learning interaction in science education in which the organization and development of the project are carried out by a project consortium. This article takes an inter-organizational learning perspective, focusing on players' motivation to engage in cooperation and supporting attractive and practical science learning. Furthermore, it contains a preliminary analysis of some important and relevant learning issues in these types of newly established networks.

The research question addressed in this paper is: *What can we learn about the potential of education-business cooperation from a concrete out-of-school network by looking at the participants' motivation and other specific issues in the network that influence the learning process?*

1 COOPERATION OF EDUCATION AND BUSINESS – A CASE DESCRIPTION

School of Technology and Business is part of the University of Applied Sciences, VIA University College) and offers higher education within technical and commercial

areas. School of Technology and Business has 3,500 students, in its technology/business education program.

Under the project leadership of VIA UC, the IEB project was a regional network collaboration between VIA, two municipalities, primary schools, high schools, and companies. The project was partly sponsored by Insero Horsens, formerly Energy Horsens, and ran over a three-year time period (2010-2013).

The purpose of the project was, according to the project description, to strengthen the interest of primary and secondary students in the areas of science, technical education, and engineering. This was attempted via combining the teaching in the schools with teaching in a company and/or another educational institution. Thus, it also intended to increase student knowledge regarding possible job opportunities (projektsamspil.dk). The project established 16 collaboration cases between educational institutions and businesses. In eight cases, the collaboration was between either a primary school class or a high school class and a company, while another eight cases involved collaboration among all three levels: primary schools, high schools, and a company. Figures 1 and 2 show two examples of teaching cources. The one is a collaboration between primary school and a metal processing company (6. graders in mathematics), and the other one is a collaboration between primary school, VIA UC and a building surveyors company (5.-8. graders geography). The educational processes that were developed are documented in education schemata, videos, teacher instructions, and educational material developed for other teachers who want to implement similar activities.

Fig. 1. Example activity

Fig. 2. Example activity

2 METHODOLOGY AND INITIAL THEORETICAL APPROACH

2.1 Methodology

This article is based on the case study of a cooperative project entitled "Interaction education and business" (IEB).

The methodological framework is rooted in action research/participant research, and the data collection includes document analysis and observations over the project period and participation in different meetings, such as the last meeting in the project consortium, which took place in May of 2013. Six semi-structured interviews were conducted with members of the project consortium, with four of these being from the project group and two being from the advisory group, seen in Figure 4.

2.2 Initial theoretical approach to the learning process in a science network

In listing important elements in the description of the learning taking place in a network, Knight mentions *"network learning episodes"* (Knight, pp. 447-448) as being:

- The learning network
- Episode time boundaries,
- The motivations/drivers for learning by the different actors
- The learning processes (how did the changes come about?)
- The learning outcome (what changes occurred?)
- Associated organizational, group, and individual learning.

The relationship between the four network learning episodes addressed in this paper is shown in Figure 3. These episodes are: (1) *players' motivation,* (2) the engagement in this specific inter-organizational *learning network*, (3) the *learning outcome(s)* and (4) the *learning process* in the network (Fig. 3). As outlined in Figure 3, episodes (2), (3) and (4) are defined by the project aims. In episodes (2), (3), and (4) we can identify important issues from the learning process in the network.

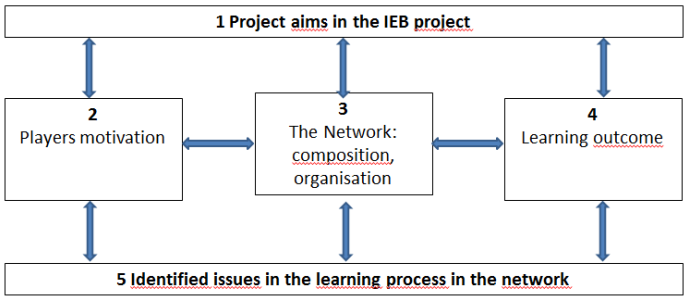

Fig. 3: Learning process as a description of selected learning episodes in the network

We can discuss if and in which ways the learning network is a learning episode, and what we understand as constituting an "episode." However, it is crucial for the learning outcomes, who are included in the network, and how the collaboration is organized. In Figure 3, we distinguish between project aims and learning outcomes, which may or may not be different. According to the project description, the project can have several purposes such as: To increase the interest amongst high school and primary school pupils in pursuing a career within the natural science and technical fields; bridge-building between the two different "worlds" of education and business communities; to offer children and young people motivating experiences by showing that technical and natural science-based knowledge can contribute to solving large-scale societal problems and challenges. Some learning outcomes are defined by the means of an array of "*cases in which scenarios have been developed and didactic models for how concrete levels of education and courses can collaborate with specific local companies and other actors*" (project description, see learning outcome as number 4 in Fig. 3). The aim is to show that educational institutions, such as primary and secondary schools, companies, and other actors, are inspired by the material and can either use it for similar course activities and/or adapt it to local conditions. Educational scenarios as used here refer to a general description of the didactic models.

When we discuss learning processes in networks, it is important to identify which levels and types of learning are needed and required by the specific actors and organizations, as well as the network as a whole. Put simply, we are asking what the

network must learn in order for its learning outcome to lead to a change in science teaching that results in more young people being interested in natural sciences and technical subjects. What we are dealing with is organizational learning. Swieringa & Wierdsma describe, based on Agyris and Schön's single and double-loop learning, a third level of learning. Single-loop learning is understood as improving *"at the rules level,"* where rules are understood as *"what we must do and are allowed to do"* (p. 13). Double-loop learning is renewal in the sense that it is changing the rules *"at the level of insights."* Here, insights refer to *"what we know and understand."* Double-loop learning typically encounters conflicts and contradictions due to, for example, different framework conditions in different organizations. Triple-loop learning is the development of new principles *"on the level of collective will and being,"* when the *"essential principles on which the organization is founded come into discussion."*

3 ANALYSIS

3.1 Description of the network and players motivation to engage in the network

The project consortium, seen in Figure 4, consists of a project group and an advisory group. The IT support group is not shown in Figure 4. The project group is responsible for planning, organizing, and implementing the project, which also means carrying out the daily work and ensuring that the project reaches its milestones in time. The project group acts as the secretariat for the advisory group and participates in the meetings of this group as described in the project description. The advisory group gives general support and has the general responsibility for the economic affairs of the project. The advisory group also provides support by offering ideas and suggestions, as well as giving positive and negative feedback (project group member 2). A member of the advisory group describes the work of the group as seeing whether the project's members "…Do what they are supposed to, and get the needed frame conditions for fulfilling [the project's] tasks. And, in connection to this, they are also supposed to make sure that the project is not twisted in a wrong direction by one or some of the participants." This statement indicates that the different participants in the network have different interests; for more on this, see the discussion on "motivation".

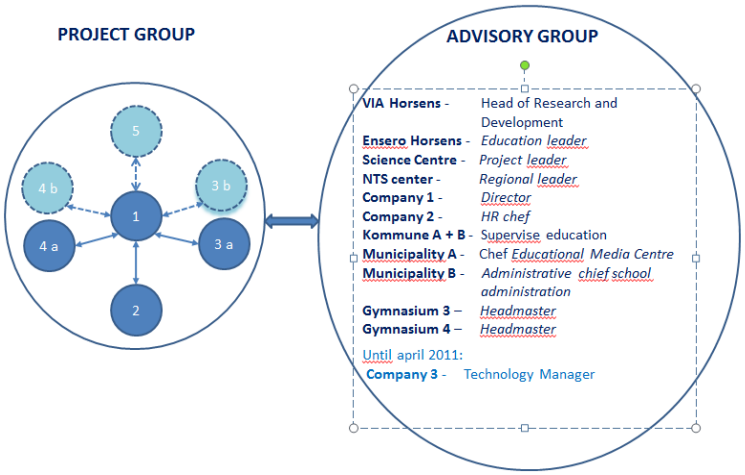

Fig. 4: The learning network in the Horsens' project consortium

Explanation of project group; **1-** VIA UC Project leader; **2-** Secondary School 1, Pedagogical leader; **3a**- Municipality A, Science coordinator and Science teacher from Primary School; **3b**- Municipality A, former member; **4a**- Municipality B, Leader Centre for Pedagogical Development; **4b**- Municipality B, former member; **5-** Secondary School 2, Science teacher, former member.

The light blue color marks the former members of both the project and the advisory board. Some changes to the board had to be made due to maternity leave and retirement. Additionally, two organizations removed themselves from the partnership: one company left the advisory board, and a secondary school left the project team. It is important to say that the network has many more members than those displayed in Figure 4, which does not include the more specific collaboration tasks involving individual teachers and business people.

What was the motivation [Fig. 3, box (2)] for each actor to enter into the cooperation? Some participants were motivated by their interest in the project aim of motivating more young people to pursue an education in science. They emphasised that *"it is an exciting way of inspiring interest"* by providing authentic learning for school children. One participant from the project group explained that *"what excited me was the cooperation,"* especially between the three operators involved: the two different levels of education, and local businesses. Another participant from the project team mentioned his motivation as being personal interest relating to his own background in natural science. For one of the participating companies, the focus was on the lack of young people pursuing vocational education: *"The problem we have is very large. I think there are very few who totally imagine ... how big the problem really is; you do not have skilled young people who are looking into the metal and engineering industries, which is a colossal problem."* The motivations of the different actors were not the same; some players were focusing on furthering engineering education, while the director wanted to address the problem of a considerable shortage of skilled workers.

3.2 Issues discussed in the network learning process

Below, there is a list of important issues [Fig. 3, box (5)] which came to light through the work of the project consortium:

- Different backgrounds, approaches, and assumptions of the participating actors and various interests at different levels. (project group member 1, member advisory group)
- Barriers to cooperation due to various conditions, especially the planning horizon in primary schools and high schools (long time horizon). Just something as simple as finding time for project team meetings was a great challenge! (project group members 1, 2)
- Geographical and organizational dispersion and a lack of contact on a daily basis. (project group members 1, 3)
- To some extent, there was a lack of knowledge implementation from the single participant in to the participating organizations.
- It has been difficult to find companies that will benefit from cooperation (project team members 3, 4a and 2 members of the reference group), *"... as one of the most difficult things was to get companies interested and involved in the project"* (member advisory group).
- *It was difficult "to get other teachers to catch the ball"*, that means to borrow the idea, and it was also difficult to get teachers to repeat successful teaching (final evaluation). One explanation is that it is difficult to make such a course fit into the daily and annual plans of public schools (project group member 2).

- A lack of business understanding and industrial insight especially in the project group with a company representative. One more science teachers, and one more representative of the upper secondary school were needed in the project group. Also, some participants expressed a desire for a greater representation of companies in the advisory board, and a better representation of secondary education.
- Will the project continue and will the project knowledge be transmitted to new users?

4 DISCUSSION AND CONCLUSION

This article describes a concrete example of inter-organizational collaboration regarding the establishment of an educational plan within natural science, both in the school and in collaboration with external actors. The collaboration was organized in a project consortium consisting of a project group and an advisory board. It was established in a specific geographical area between primary and secondary schools, VIA UC, two municipalities, and local companies, as shown in Figure 4. The collaboration has been running over three years and can be described as a rather loose network, as described on the definition page.

The following quote illustrates the success of the project: "*We have got some really good educational experiences and teaching. It is no longer unnatural to talk about collaboration between schools and companies – we have come that far! But we still have a long way to go from theory and understanding to get it really implemented"* (project group member 2).

It was a significant challenge for the project group to find school teachers and companies who were willing participate in this type of collaboration. *"We would like to tear down these barriers, but we still don´t exactly know which barriers we are dealing with; however, we certainly know that something still produces a distance between the schools and the companies"* (project group member 1).

In order to utilize the potential that we believe can be gained by collaboration between education and business, we would like to emphasise the following:

The participating actors shown in Figure 4 all have very different framework conditions, interests, and motivational structures when they try to engage in this type of collaboration. The different organizations in the network are all embedded with specific institutional conditions, which again influence the possibilities of the network. An analysis of the network shows that important potentials can be realized if the network is designed in a systematic way with regard to participants and competencies. Both the types of participants and the organization of the network should be adequate in relation to the desired learning outcome or the educational needs of theyoung people the programme is seeking (see Fig. 3).

It is through collaboration between educational institutions and businesses that it becomes possible to develop authentic, pupil-centred, and problem-based education in the natural sciences. However, we are dealing with a new type of collaboration that requires systematic, long-term cooperation in order to build a bridge between the vastly different worlds of education and business. As emphasised by one of the members of the advisory group, in future collaboration, it would be necessary to allocate resources for a person in a coordinator position. Another member underlines the necessity of getting more spare time to be used for the exchange of knowledge and experiences, with the goal of getting deeper into the subject matter in order to find points of interest and create motivation (fig 3). With this type of long-term

collaboration, it could be possible for this “wide network” to evolve and become a strategic network (Knight, 2002). This type of collaboration would make it possible to systematically work on identifying and removing barriers that impede collaboration. It is necessary that the leaders in the participating organizations create conditions that support collaboration and ensure that the knowledge and experiences gained from it become embedded in the different participating organizations. The IEB project has developed a platform now, and further development can go on.

Further research is needed on the barriers and drivers of inter-organizational collaboration supporting the goal of increasing the attractiveness of engineering and technical education. Also needed is a debate of which type of knowledge and learning level is most valuable in this innovative collaboration aimed at organizing attractive, authentic, problem-based learning in the teaching of sciences.

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